World J Surg (2011) 35:297–301
DOI 10.1007/s00268-010-0874-9

World Journal of Surgery

# Long-term Follow-up of Open and Laparoscopic Repair of Large Incisional Hernias

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Published online: 7 December 2010


**Abstract**
*Background* Long-term results after laparoscopic repair of large incisional hernias remain to be determined. The aim of this prospective study was to compare early and late complications between laparoscopic repair and open repair in patients with large incisional hernias.
*Methods* Only patients with a hernia diameter of ≥5 cm were included in this study and were prospectively followed. We compared 56 patients who underwent open incisional hernia repair with 69 patients who underwent laparoscopic repair. Median follow-up in the laparoscopic group was 32.5 months (range 1–62 months) and in the open group 65 months (range 1–80 months).
*Results* The demographic parameters were not significantly different between the two groups. However, the median hospital stay (6.0 days, range 1–23 days vs. 7.0 days, range 1–67 days; $p = 0.014$) and incidence of surgical site infections (SSIs) (5.8% vs. 26.8%; $p = 0.001$) were significantly lower in the laparoscopic group than in the open surgery group. Bulging of the implanted mesh was observed in 17.4% in the laparoscopic group and in 7.1% in the open group ($p$ = NS). The recurrence rate was 18% in the open group and 16% in the laparoscopic group ($p$ = NS). Multivariate analysis revealed that width of the hernia ≥10 cm, SSI, and BMI ≥30 kg/m$^2$ were significant risk factors for hernia recurrence.
*Conclusions* The incidence of SSIs was significantly lower after laparoscopic incisional hernia repair. At long-term follow-up, the recurrence rate was not different between the two techniques. Abdominal bulging is a specific problem associated with laparoscopic repair of large incisional hernias. Size of the hernia, BMI, and SSI are risk factors for hernia recurrence irrespective of the technique.

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## Introduction

Incisional hernia is a common complication after abdominal surgery, with an incidence as high as 26% [1–4]. As shown in various randomized controlled trials, laparoscopic incisional hernia repair is feasible and safe [5–8]. However, the practicability of this technique for a large incisional hernia repair has not been described in detail.

For the repair of large incisional hernia, both techniques, open and laparoscopic, are associated with specific technical difficulties. With the open repair the main problem is closure of the fascia under tension, whereas with the laparoscopic repair increased abdominal pressure requires efficient mesh fixation to stabilize the mesh sufficiently. The aim of this study was to evaluate prospectively the outcomes of laparoscopic repair of large incisional hernias versus open surgery.

## Materials and methods

### Patients

Between February 2003 and June 2009, a total of 428 consecutive patients underwent incisional hernia repair at our institution. Data for all patients undergoing open and laparoscopic incisional hernia repair were collected prospectively by a study nurse and kept in an electronic

database. The present study included only the subset of patients with a hernia diameter of ≥5 cm. A total of 125 patients met the study criteria. Laparoscopic hernia repair was started in July 2004. Patients treated before July 2004 underwent open hernia repair; all patients treated after July 2004 underwent laparoscopic hernia repair except in the presence of anesthetic (severe pulmonary disease) or technical contraindications (eviscerated organs).

We compared 56 patients who underwent open incisional hernia repair with 69 patients who underwent laparoscopic repair. Clinical long-term follow-up investigations were performed during autumn 2009 at our institution by a single investigator who was not involved in the medical care of the patients. Clinical follow-up was obtained on 51 patients after laparoscopic repair (80%) and 30 patients after open repair (75%). Median follow-up was 32.5 months (range 1–62 months) in the laparoscopy group and 65 months (range 1–80 months) in the group undergoing open surgery ($p < 0.001$). Clinical examinations were done and questionnaires filled out by general practitioners if the patients were unwilling or unable to undergo ambulatory consultations at the referral center. In all, 22 patients (17.6%) died before autumn 2009: 6 patients from the laparoscopic group and 16 from the open surgery group.

### Surgical technique

Preoperative antibiotic prophylaxis was given in both groups. The technique of open incisional hernia repair included implantation of preperitoneal mesh as described by Rives et al. [9]. Briefly, the polypropylene-based mesh was placed on the posterior rectus sheath after suturing the posterior rectus sheath and/or the peritoneum. A component separation technique was performed in 12 patients due to hernia localization. The mesh was fixed with nonabsorbable sutures. An abdominal belt was applied, and drainage was performed routinely.

The same technique as described previously was used for the laparoscopic incisional hernia repair [4, 10]. Using a limited open technique we inserted an optical trocar; and under direct vision, we added two more trocars at a suitable distance from the hernial orifice. We implanted a large dual-layered mesh (polypropylene or polyester) with a minimum 5-cm overlap of the defect. Nonabsorbable transfascial sutures were used caudal and lateral of the hernia every 4–6 cm. Titanium tackers were applied between the sutures every 1–2 cm around the hernial orifice and cranial to the hernia into the diaphragm. To prevent seroma formation, we routinely applied a compression dressing over a period of 7 days.

### Outcome parameters

Currently, there is no generally accepted classification of incisional hernias, which makes it impossible to compare studies concerning the characteristics of the hernia. We used the classification as established and published by the consensus meeting of the European Hernia Society held in Ghent, Belgium in 2008. The classification comprises a division of subgroups for incisional hernia, including localization, width, and length of the hernia [11].

Recurrence was defined as any abdominal wall gap with or without bulge that is not covered by mesh in the area of a postoperative scar. Recurrent hernia was diagnosed by physical examination. Only in cases of uncertainty was an additional computed tomography (CT) investigation performed.

Surgical site infections (SSIs) were assessed according to the criteria developed by the Centers for Disease Control and Prevention (CDC) [12]. Infections are categorized as incisional (superficial or deep) infections or organ-space infections. Superficial SSIs involve only skin and subcutaneous tissue and exclude stitch abscesses. Deep SSIs involve deeper soft tissues at the site of incision. Organ-space SSIs are defined as infections in any organ or space.

The threshold for chronic pain was set at 3 months postoperatively according to the International Association for the Study of Pain [13].

The primary outcome measure was the recurrence rate after open repair and after laparoscopic repair of a large incisional hernia. Secondary outcome measures were long-term complications such as SSI, pain, bulging, seroma, and intestinal fistula.

### Statistical analysis

Analysis was by intent to treat. Student's *t*-test was performed to determine the significance between continuous variables and Fisher's exact test to compare proportions. The log-rank test was performed for univariate testing. The *p* values were two-sided, and <0.05 was used as the threshold for statistical significance (NCSS 2004 for Windows; NCSS, Kaysville, UT, USA).

## Results

A total of 125 patients with a hernia diameter ≥5 cm were included in this study. In all, 69 patients underwent laparoscopic repair, and 56 patients had open incisional hernia repair (Table 1). Demographic parameters, including age, sex, and BMI, were similar in the two groups. Recurrent hernia was present in 19.2%.

**Table 1** Patients' characteristics

| Characteristic | Laparoscopy group ($n = 69$) | Open group ($n = 56$) | $p$ |
|---|---|---|---|
| Age (years)[a] | 63.0 (29–87) | 63.5 (38–83) | NS* |
| Sex | | | |
| Female | 19 (27.5%) | 18 (32.1%) | NS** |
| Male | 50 (72.5%) | 38 (67.9%) | |
| BMI (kg/m$^2$)[a] | 29.2 (21.2–40.1) | 27.5 (18.8–51.1) | NS* |
| Recurrent disease | 13 (18.8%) | 11 (19.6%) | NS** |

*BMI* Body mass index

[a] Values are the median (range)

* Student's *t*-test

** Fisher's exact test

Hernia characteristics according to the classification of the European Hernia Society (EHS) are shown in Table 2, including hernia localization and size. Although overall size is comparable between the two groups, significantly more patients with a width of ≥10 cm were found in the laparoscopy group ($p = 0.04$). Multiple hernial orifices were found in 51% in the laparoscopic group and in 57% in the open group ($p$ = NS).

Operative results are shown in Table 3. Laparoscopy was converted to open surgery in seven patients (10%) because of massive adhesions. Additional open cutaneous excision was performed in three patients in the laparoscopy group.

**Table 2** Characteristics of the hernias

| Characteristic | Laparoscopy group ($n = 69$) | Open group ($n = 56$) |
|---|---|---|
| Midline | | |
| Subxiphoidal (M1) | – | 3 (5.4%) |
| Epigastric (M2) | 27 (39.1%) | 21 (37.5%) |
| Umbilical (M3) | 21 (30.4%) | 19 (34.0%) |
| Infraumbilical (M4) | 6 (8.7%) | 1 (1.8%) |
| Suprapubic (M5) | – | – |
| Lateral | | |
| Subcostal (L1) | 5 (7.2%) | 6 (10.7%) |
| Flank (L2) | 8 (11.6%) | 3 (5.4%) |
| Iliac (L3) | 2 (2.9%) | 3 (5.4%) |
| Lumbar (L4) | – | – |
| Recurrent incisional hernia | | |
| Yes | 13 (18.8%) | 11 (19.6%) |
| No | 56 (81.2%) | 45 (80.4%) |
| Length (cm)[a] | 12 (5–30) | 10 (5–25) |
| Width[a] | 8 (4–20) | 6 (2–20) |
| <4 cm (W1) | 1 (1.5%) | 5 (8.9%) |
| ≥4–10 cm (W2) | 33 (47.8%) | 17 (30.4%) |
| ≥10 cm (W3) | 25 (36.2%) | 11 (19.6%) |

[a] Values are median (range)

**Table 3** Procedure and hospitalization

| Parameter | Laparoscopy group ($n = 69$) | Open group ($n = 56$) | $p$* |
|---|---|---|---|
| Operating time (min) | 180 (60–360) | 180 (85–375) | NS |
| Blood loss (ml) | 50 (10–450) | 100 (20–2500) | 0.001 |
| Hernia size (cm$^2$) | 25.7 (3.9–117.8) | 20.9 (3.5–94.6) | NS |
| Mesh size (cm$^2$) | 600 (600–1250) | 500 (250–1000) | <0.001 |
| Conversion rate | 7 (10%) | – | |
| Hospital stay (days) | 6 (1–23) | 7 (1–67) | 0.014 |

Values are the median (range) unless otherwise stated

* Student's *t*-test

Significantly more SSIs occurred in the open group than in the laparoscopy group (5.8% vs. 26.8%; $p = 0.006$). Incisional superficial SSIs were found in 14 (25%) patients in the open group and in 3 (4.3%) patients in the laparoscopy group ($p = 0.001$). One patient in the laparoscopy group and two patients in the open group with an organ-space infection underwent open revision and vacuum-assisted closure (VAC) therapy. One patient in the open group underwent mesh explantation. The recurrence rate was 16% in the laparoscopy group and 18% in the open group ($p$ = NS). There were seven epigastric and four lateral iliac recurrences in the laparoscopy group (11 patients), whereas there were four epigastric, one umbilical, four lateral iliac, and one unknown site recurrences in the open group (10 patients). Mesh bulging occurred in 12 patients in the laparoscopy group and in 4 patients in the open group ($p$ = NS); it was disturbing to 9 patients (56%). Reoperations were performed in the laparoscopy group owing to recurrence (nine patients), infection (three patients), and for diagnosis of a suspected infection (one patient); in the open group, reoperation was undertaken because of recurrence (six patients), infection (eight patients), seroma (one patient), and intestinal fistula (one patient). Postoperative chronic pain was observed in 18.8% of the laparoscopy group and in 10.7% of the open group (Table 4).

Risk factors for recurrence were assessed using multivariate analysis, including the following factors: body mass index (BMI) ≥30 kg/m$^2$; SSI; width ≥10 cm; multiple hernial orifices; open surgery technique. Significant risk factors for recurrence were BMI ≥30 kg/m$^2$; hernia width ≥10 cm, and SSI. Surgical technique and multiple hernial orifices were not risk factors for hernia recurrence (Table 5).

## Discussion

This prospective study shows that laparoscopic incisional hernia repair can be performed safely in patients with large abdominal wall hernias. Short-term results show

**Table 4** Early and late morbidity

| Parameter | Laparoscopy group ($n = 69$) | Open group ($n = 56$) | $p$* |
|---|---|---|---|
| SSI | 4 (5.8%) | 16 (26.8%) | 0.006 |
| Incisional, superficial | 3 (4.3%) | 14 (25%) | 0.001 |
| Incisional, deep organ space | 1 (1.4%) | 2 (3.6%) | NS |
| Intestinal fistula | 0 (0) | 1 (1.8%) | NS |
| Seroma | 4 (5.8%) | 8 (14.3%) | NS |
| Recurrence | 11 (15.9%) | 10 (17.9%) | NS |
| Mesh bulging | 12 (17.4%) | 4 (7.1%) | NS |
| Reoperation | 17 (24.6%) | 16 (28.6%) | NS. |
| Pain at follow-up (VAS) | 0.6 (0–6) | 0.5 (0–5) | NS** |
| Return to work (weeks) | 3 (0–50) | 6 (0–28) | NS** |

Values are the median (range) unless otherwise indicated

*SSI* Surgical site infection; *VAS* visual analog scale

* Fisher's exact test unless otherwise indicated

** Student's *t*-test

**Table 5** Multivariate analysis of risk factors for recurrence after large incisional hernia repair: logistic regression analysis

| Factor | Odds ratio (95% CI) | $p$ |
|---|---|---|
| BMI $\geq$30 kg/m$^2$ | 1.6 (1.1–2.5) | 0.03 |
| Surgical site infection | 2.0 (1.3–3.2) | 0.002 |
| Width $\geq$10 cm | 1.7 (1.1–2.7) | 0.02 |
| Multiple hernial orifice | 0.7 (0.5–1.1) | 0.14 |
| Open technique | 1.1 (0.7–1.8) | 0.6 |

*CI* Confidence interval

significantly decreased SSIs and duration of hospitalization. At the long-term follow-up, the recurrence rate and chronic pain were comparable to those with open hernia repair.

Reduced SSIs and shorter hospital stays are the major short-term advantages associated with laparoscopy and are most likely the consequence of the reduced wound size [14–16]. As shown in our series, benefits associated with laparoscopy for large hernia repair are similar to the results obtained with laparoscopic repair of a small hernia, which has been explored in previous trials [5–8, 14, 16]. However, obesity is discussed as a contraindication for laparoscopic large incisional hernia repair [17]. Our results show that obesity does not represent a contraindication even for laparoscopic repair of large incisional hernias.

The technical hurdles associated with large incisional hernia repair have been mastered, as shown by a conversion rate of 10%. This rate for these large hernias is comparable to that in another study, which reported a conversion rate of 11% and included mainly small incisional hernias [5]. In our study group, conversion to open surgery was in all cases due to massive adhesions. The reasons for a relatively long operating time in the laparoscopy group are complete adhesiolysis and mesh fixation every 4–6 cm with transfascial sutures.

Time to return to work and chronic pain were taken as functional outcome parameters in our study group. There was a tendency of faster return to work in the laparoscopy group, probably because of a significantly lower incidence of SSIs and shorter hospital stays. Postoperative chronic pain in the abdominal wall occurred in 18.8% in the laparoscopy group and in 10.7% in the open group. However, no significant difference in the median visual analog scale (VAS) score (0–100) between the two groups was found. The difference in the duration of long-term follow-up potentially explains such a difference. In the laparoscopy group, chronic pain was mostly localized next to the transfascial sutures, probably as a result of nerve entrapment. Three patients in the laparoscopy group underwent reoperation owing to nerve entrapment. Our data show that such chronic pain is significantly reduced after follow-up of more than 6 months [18].

Recurrence rate is one of the most important long-term outcome parameters in both laparoscopic and open incisional hernia repair. Overlap of the fascia and mesh fixation, particularly for large incisional hernia repair, minimizes the recurrence rate. In our study, we implanted the mesh with a minimum 5-cm overlap of the defect. The mesh was fixed not only at the edges but also around the hernial orifice. Previous series observed recurrence rates between 2 and 10% for laparoscopic repair and between 1 and 8% for open repair during a follow-up of 12–24 months [5, 8]. However, a follow-up of 3 years has been shown to be mandatory to assess the recurrence rate correctly [19]. During a follow-up of 33 months for the laparoscopy group and 65 months for the open group, the recurrence rate for the laparoscopy group was 16% and for the open group 18%. We cannot exclude a recurrence rate higher than 16% in the laparoscopy group after a follow-up similar to that of open surgery, however. We demonstrate with our study that a width of the hernial orifice $\geq$10 cm is a significant risk factor for hernia recurrence. Technical difficulties of lateral fixation leading to insufficient lateral overlap of the mesh could be the main explanation for the higher recurrence rate after large hernia repair. In addition to hernia width, BMI $\geq$30 kg/m$^2$ and SSIs have been identified as significant independent risk factors for recurrence after large incisional hernia repair, similar to previous investigations [19, 20].

Abdominal bulging as observed in our study is a specific problem associated with laparoscopic repair of large incisional hernias in our study group and appears in 56% of patients. Asencio et al. [5] described considerable laxity

and bulge after laparoscopic incisional repair of large hernias. Closure of the fascia is a potential way to reduce bulging [21, 22]. However, fascial closure of large abdominal hernias is often difficult to achieve and is associated with significant tension of the sutures. To enhance cosmetic results in the laparoscopy group, we suggest additional open cutaneous excision.

Limitations of the study are a lack of randomization and the shorter follow-up of the laparoscopy group. However, most of the recurrences appeared prior to the mean follow-up of 33 months in the laparoscopy group.

## Conclusions

Laparoscopic repair of large incisional hernias is technical feasible. It is associated with fewer SSIs but has a recurrence rate comparable to that seen with open hernia repair. Short-term benefits have been shown in patients undergoing laparoscopy. However, technical advances to decrease pain and bulging are necessary to improve long-term outcomes with laparoscopic incisional hernia repair.

**Conflict of interest** Drs. Anita Kurmann, Eva Visth, Daniel Candinas, and Guido Beldi have no conflicts of interest or financial ties to disclose.

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